



## MOTOR VEHICLE

## BACKGROUND OF THE INVENTION

Field of the Invention

The present invention concerns a motor vehicle comprising at least

5 one electric motor, an energy storage device for providing drive energy for the electric motor, a plug connector connected to the energy storage device for connection to a current source and a control means for controlling the flow of current from the current source to the energy storage device.

Description of the Related Art

10 Vehicles which store electric charge have already been known for some time and are eminently suitable for journeys over short and medium distances. In order to make such a vehicle usable the available energy storage device has to be charged up. When the vehicle has covered a certain distance the storage device has to be charged up again. In that case, a careful driver will re-

15 charge the energy storage device after each journey in order always to have at his disposal the greatest possible range.

As state of the art reference is made generally at this point to the following publications: DE 692 20 228; DE 197 22 644 and P 43 37 978.

As journeys with the electric vehicles - like with all other vehicles -

20 cannot always be exactly planned in advance, it can happen with such a procedure that the energy storage device of the vehicle is to be charged up precisely when the cost of the energy is at its highest, and when in addition the supply network is most heavily loaded, for example during what is referred to as a midday peak.

That is disadvantageous both because of the high price of buying the energy while it is also disadvantageous because of the loading on the supply network which in any case is already highly loaded.

#### BRIEF SUMMARY OF THE INVENTION

5                   A motor vehicle having an electric charge storage device has a control means that permits a flow of current from the energy storage device to a current source. Namely, in that way, an electrical power network a flow of current can take place from the energy storage device of the motor vehicle back into the network and can thus contribute to covering the peak demand.

10                   In a preferred embodiment of the invention the flow of current from the energy storage device to the current source, that is to say for example into the current network, is controlled in such a way that a predeterminable residual amount of electrical energy is retained in the storage device, by the control means interrupting the flow of current to the network when said predetermined residual  
15 charge amount is reached. For that purpose, there is provided a device for detecting the amount of charge in the energy storage device.

                    In a preferred development of the invention the control means communicates with the network through a communication device so that the draw of energy can be controlled in the optimum fashion from the network, in  
20 dependence on the location of the motor vehicle and the available amount of charge.

                    Particularly preferably the control means is designed in such a way that it includes a clock or is connected to a clock. In that way the control means can operate in such a fashion that charging and discharging operations take place  
25 in predeterminable periods of time. It is possible in that way to provide that the energy storage device is preferably charged up at night when on the one hand the loading on the supply network is low and on the other hand the costs of charging it up are low, while discharging preferably takes place at times when relieving the

load on the supply network makes sense and the costs of the energy are higher than the costs during the charging procedure. In that way it is also possible to achieve an economic advantage, from the point of view of the operator of the vehicle, besides relieving the load on the supply network.

## 5 BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

An embodiment of the invention is described in greater detail hereinafter with reference to the following figures:

Figure 1A is a block diagram of a first embodiment of the invention.

Figure 1B is a block diagram of an alternative embodiment of the  
10 invention.

Figure 2 shows a conventional day chart of the power demand in the case of an electrical power supply utility.

Figure 3 shows a charge condition time table with the charge condition of a vehicle according to the invention.

## 15 DETAILED DESCRIPTION OF THE INVENTION

Figures 1A and 1B show a simplified block circuit diagram of the arrangement according to the invention. Reference 1 denotes a frame which includes those components which are associated with the motor vehicle.

Accordingly the motor vehicle includes a control means 10. The control means 10  
20 is connected to an energy storage device 20, a drive motor 40 and a releasable connector 50 which for example is in the form of a plug connector. There is also a connection between the connector 50 and a current source 30 which here is indicated in the form of one component an electric power network 32. If the current source 30 is AC power and the storage device is DC power, as is common,  
25 an inverter 60 is provided that converts AC power to DC power and vice versa. The term electric power network 32 is to source to be understood in their broadest terms. Any source of power outside of the vehicle itself is considered part of the

electric power network 32. Thus, any source to provide current or to receive current is considered part of the electric power network 32, whether public or private, large or small.

In order to provide sufficient energy for operation of the motor vehicle 1, the control means 10 monitors the charge condition of the electrical energy storage device 20 which can be for example a battery, but also can be a capacitor storage device or the like. When the storage means 10 recognizes that charging of the storage device 20 is required, the control means allows a flow of current from the network 30 to the storage device 20 by way of the connector 50 and the storage device 20 is charged up. It will be appreciated that, in that case, the control means 10 will also take account of the corresponding charged status and the charging characteristics of the storage device 20 so that overcharging of the storage device 20 is reliably prevented and that overdepleting of the charge is avoided.

The control means 10 can also permit charging during a predeterminable first period of time. That makes it possible for the storage device 20 to be preferably charged up at night when on the one hand the price of the electric current is low and thus the costs involved in charging the storage device 20 also remain comparatively low while on the other hand the loading on the supply network 30 is not very high. In addition the control means 10 can be so designed that it permits a flow of current from the storage device 20 by way of the plug connector 50 and inverter 60 into the network 32. In that respect the amount of charge which can be delivered can be limited to always maintain a predeterminable residual amount of charge at the storage device 20.

In that way, for example, after a journey to the place of work, with the storage device 20 fully charged, the energy which is still present in the storage device 20 can be fed into the network 32 again if the demand is particularly high, for example for the midday peak. However the control means interrupts the flow of current from the storage device 20 into the network 32 only when a

predeterminable residual amount of charge remains in the storage device 20, so that at any event an adequate amount of energy in the storage device 20 for the return journey in the evening is guaranteed. In one embodiment, the amount of residual charge left can be programmed by the user to be a custom amount based  
5 on the distance they need to drive as minimum. For example, some users may wish to always store 20 km of travel charge, while other users may wish to store 10 km or 60 km of travel charge. The user can selectively program the amount of residual charge that must remain when power is transferred from the motor vehicle to the system, in one embodiment. Accordingly, the vehicle 1 is fitted with a  
10 current meter/energy cell 80 which measures the electrical energy received in the storage device 20 and energy fed into the supply network 32.

It will be appreciated that the current which is fed into the network at the peak time is to be suitably reimbursed so that, besides the aspect of relieving the load on the network, there is also an economic advantage to be achieved.

15 It was proposed in accordance with the invention that a vehicle 1 with an electrical energy storage device 20 is also to be used as an energy source for a power supply network 32 from which the vehicle 1 possibly draws its energy.

As is known, the power demand during the day is markedly higher than the power demand at night. Thus for example the power demand in a public  
20 power supply network rises from a low point, usually between 1 o'clock and 4 o'clock at night, toward a first peak in the morning (morning peak), reaches its highest level (midday peak) around midday, and then decreases in the evening again until it reaches its low level in the middle of the night. As therefore the energy demand at middle of the night is markedly lower than the usual available  
25 energy supply and the consumers also take night-time power, it is markedly lower in price than the price for daytime power.

An electrical power supply network 32 then has to be designed in such a way that it has to cover without any problem not only the demand at night, but also the demand at the highest daytime peaks. In regard to the electrical

supply utilities, that means that a large number of electrical energy generators must be provided, which reliably guarantee that such a demand is met, even at very high midday peaks (on a cold winter's day).

The invention proposes that an electric vehicle 1 which usually draws  
5 its electrical energy from an electrical supply network 32 and which therefore also has suitable connections with a connection to an electrical power supply network 32 need not be charged up with the electrical energy from the power supply network 32 at peak usage times, but if necessary, at a given moment in time, can also feed energy that is not required, into the supply network 32.

10 If it is first assumed that the vehicles 1 have to be used by the population working on weekdays, only in the periods between 7 am and 8.30 am and about 4.30 pm and 6.30 pm, such a motor vehicle 1 is in a parking place, without being used, for most of the day. Charging up the energy storage device of the electric vehicle 1 at night at the home of the owner of the vehicle 1 is not a  
15 problem and has also already been done. What is new however is the proposal according to the invention that, after the motor vehicle 1 has reached the place of work, it is also connected to an electrical current network 32 in order then to provide the energy which is necessary as required, for the peak power times. Accordingly, the control means 10 includes a clock 90, or is connected to a clock  
20 90.

If in that case the motor vehicle 1 has batteries 20 which discharge/charge up very quickly, it is therefore possible, just with a number of 500 - 1000 units of that nature, to provide a very high level of feed-in power for the network.

25 The particular advantage for the electrical power supply utility is that it can have recourse to an electrical energy storage device 20 which it has not paid for itself and for the maintenance of which it also does not have to bear responsibility. From the point of view of the user of the vehicle 1, the advantage of the invention is that, for example at the midday time when therefore he does not in

any case require his motor vehicle 1 because he is at his place of work, he virtually rents the storage device, which is still well filled, of his vehicle 1, to the electrical power supply utility, and can sell the energy contained therein. The consumer can therefore feed the electrical energy from his vehicle 1 into the power supply  
5 network 32 at midday and will receive a payment or credit at a comparatively high price, while at night he has to arrange for charging up his vehicle 1 at a low price (night-time current rates).

It will be appreciated that, in accordance with the invention, it is also provided that the electrical storage device 32 of the vehicle 1 does not fall below a  
10 given minimum level and, if necessary, the electrical storage device 20 of the vehicle 1 can also be charged up again after the midday peak, more specifically when the demand in the network has decreased again in the afternoon.

It can however also be provided that the user individually adjusts his vehicle 1 in such a way that, in the evening, he has sufficient energy to complete  
15 his journey home (minimum content of energy with a sufficient level of certainty of arriving home) so that total charging of the storage device 20 is only effected again during the following night, with the corresponding night-time current.

Therefore, by means of suitable programming, possibly also by way of remote input, such as the user employing his cellular phone, the user of the  
20 vehicle 1 can also predetermine the periods or the times within which only discharging of his storage device 20 can take place and/or the amount of discharge permitted.

The invention is suitable in particular in combinations where there are large parking lots and large multi-story car parks. The invention seems to be quite  
25 particularly suitable for use in multi-story car parks at airports, in particular those airports which carry holiday traffic, for at such car parks there are often many thousands of private cars which are completely unused for an average of 7 - 14 days. During that period, a suitable power management system at the corresponding connection of the vehicles 1, if they are in the form of electric

vehicles according to the invention, could be made available to the electrical power supply network 32 which discharges the respective storage devices of the vehicles 1 at peak times and charges the storage devices 20 of the vehicles 1 with electrical energy again at the periods of lower demand.

5                   The invention is described in greater detail hereinafter by means of an embodiment illustrated in the drawing.

                  The electrical storage device of the vehicle 1 is equipped with a suitable electronic control means (power management system 10) which makes it possible to trigger and control not only electrical charging but also discharging of  
10   the storage device 20.

                  In addition the power management system 10 can also be programmed in such a way that discharging is possible only for a quite specific time which is predetermined by the user. For example, it can be provided that discharging and thus a feed of power into the electrical energy supply network 32  
15   is possible only during the time from 10 am to 3 pm, otherwise, when the vehicle 1 is connected to the supply network 32, the battery is being correspondingly charged.

                  The power management system 10 can also be programmed in such a way that, when discharging is effected in the period from 7 am to 4 pm, charging  
20   does not take place straightaway, but charging occurs only in the night period between 12 midnight and 4 am, that is to say when particularly appropriate night-time current is to be taken from an electrical supply network 32.

                  In addition the power management system 10 of the vehicle 1 can be programmed in such a way that basically a minimum amount of charge remains in  
25   the storage device 20, that is to say cannot be fed into the supply network 32, in order in any case to ensure that the user can properly travel the distance that he wants, in his vehicle, that is to say for example the journey home from his place of work.



It will be appreciated that still further programming modes are possible, so that the power management system 10 can also be set by the user himself, in just any conceivable manner, according to his respective wishes, while if necessary there is the possibility of a feed into the power supply network.

5                   As can be seen from Figure 2 the current/energy demand of an electrical supply utility (ESU) is not distributed linearly over the entire day, but rises from a lowest point early in the morning (about 1 am to 3 am), reaches a first morning peak, then later reaches the so-called midday peak, that is to say its highest point, and then decreases irregularly towards the night again. The  
10   electrical power supply network 32 which has the responsibility of always making sufficient electrical energy available to the consumers connected to the electrical supply network 32, even at peak times, not only has to ensure that appropriate energy is fed into the supply network 32, but also that there is always so much energy in readiness that, at all times, that is to say even at extraordinary peak  
15   times, the responsibility of providing an electrical supply with electrical energy at a constant voltage level and a constant frequency is always met. It is apparent that a large number of control interventions both on the producer side and also in terms of the distribution of electrical energy is already required nowadays for that purpose.

20                   Figure 3 shows a configuration by way of example of the charge condition of the electrical storage device 20 of a vehicle 1 according to the invention. In the electrical storage device 20 which was charged with night-time current during the night, and which therefore exhibits a one hundred percent filling (I), that charge condition falls, in the morning journey (II) to the place of work.  
25   When the place of work is reached (III) and the vehicle is connected by way of the electric lines to the electrical supply network 32, the charge condition is possibly returned to one hundred percent again. At the midday time (IV), that is to say when the midday peak occurs (see Figure 2), a large part of the stored electrical energy in the storage device is fed into the connected electrical supply network 32

so that the charge condition correspondingly falls within a very short time to a prescribed minimum (V). That minimum has been set by the user or the vehicle manufacturer (it can also be set in another fashion) and should be sufficient for the vehicle 1 to be able to still make the journey home, without charging it up

5 beforehand.

In the illustrated example however the charge condition can also be increased again in the afternoon (VI) by taking energy from the supply network and during the journey home (VII) the charge condition further falls again. When the electric vehicle 1 is subsequently connected to the electrical power supply network  
10 the charge condition can be restored to the prescribed value (100%) again in the evening/at night (VIII).

It should be pointed out once again that the configuration as set forth in Figure 3 is given purely by way of example.

If the electric vehicle 1 has a suitable input surface, the user of the  
15 vehicle 1 can execute a large number of setting adjustments.

Thus for example, by means of a suitable input, the user can predetermine the periods of time, within which only discharging of the electrical storage device 20 can take place at all, when connected to an electrical supply network 32. The user can also set the amount of residual charge below which the  
20 battery 20 will not be discharged in order to ensure an adequate amount to travel to a given location.

As corresponding documentation of the charging and discharging operations shows, the user, even after several days, can still see when and what amounts of energy were fed into the electrical supply network 32.

25 Besides the electrical storage device 20, for example a lithium battery or another storage technology, the vehicle 1 according to the invention has a suitable power management program 10a for controlling the charge condition of the electrical storage device and for evaluation of the inputs of the user and also for documentation purposes.

In addition the vehicle 1 can have a suitable data interface 70 (besides receiver/transmitter 70a for wireless (cellular phone) control) so that the vehicle 1 can send to or receive from a suitable interface of the electrical power supply utility 32, all data which are necessary for charging and also for discharging  
5 (feed into the network 32). Accordingly, embodiments of the vehicle 1 may be fitted with a current meter/energy cell 80 which measures the electrical energy received in the storage device 20 and energy fed into the supply network 32, and a recording unit 100 which establishes when and what amount of electrical energy was charged into the storage device or fed into the electrical supply network.  
10 Further, the vehicle 1 may have an electrical connection plug 110 which can be connected to a corresponding connection plug 120 of the electrical supply network 32, wherein the connection plug 120 has a ground line 130, by means of which data of the vehicle 1 can be exchanged by way of a data network 140 of the electrical supply utility and in addition further data can be fed in by way of the data  
15 network 140.

That facilitates documentation of the respective discharging and charging conditions/times and billing thereof. In regard to billing, account is to be taken of the fact that current which is fed into the network 32 at the midday peak can be reimbursed at a better price than night-time current which usually can be  
20 made available without any problem and at a better price in relatively large amounts.

Discharging of the storage device 20 with the feed of electrical energy into the power supply network 32, that this then involves, can also be used for possibly appropriately charging other vehicles 1 with an electrical storage  
25 device 20, the charge condition of which has become too low, to such an extent that those vehicles can still continue to travel.

Therefore the invention also permits a plurality of vehicles 1 to be electrically connected together, with their electrical storage devices 20.

The present invention also provides that the electric current (electric voltage) of the electrical storage device 20 of the vehicle 1, for being fed into the current source 30 (network), is converted by an inverter 60 so that the feed into the current source is possible. That inverter 60a can be provided in each vehicle 1 but  
5 on the other hand it is also possible for the electric current of the energy storage device to be firstly taken from the vehicle 1 by direct current transmission and for the inverter 60b then to be provided outside the vehicle 1 (as viewed from the vehicle, downstream of the network and the connection of the vehicle) so that the electrical power taken from the vehicle 1 can be produced by an inverter for the  
10 feed into the network (for example 50 Hz, network voltage etc).

It is also particularly advantageous that a central inverter station 60b is provided – for the delivery of direct current for the storage device in the vehicle but also for the feed of alternating current into the network - , which for example is provided at garage installations (for example at airports) as here large amounts of  
15 electrical energy can occur at such garage installations if a correspondingly large number of vehicles 1 according to the present invention are connected. In that way the costs of the inverters 60 are overall kept at a relatively low level and at the same time it is possible to provide for a methodical feed of alternating current into the electrical network as it is relatively simple to control individual or relatively large  
20 inverter stations than many small inverters 60a in vehicles 1, which ultimately could also result in disturbances, for example harmonics, in the network.

As an inverter 60a also has a degree of efficiency of less than 1, even if it is only slightly below the ideal value of 1, the losses from an inverter 60 in a vehicle 1 (Figure 1a) are certainly higher than in the case of a stationary, central  
25 inverter 60b (Figure 1b).

In the case of a domestic connection also the inverter can be associated therewith so that an individual vehicle, can certainly also feed back energy, at its parking space at home.

As it is certainly the case that working people frequently have to cover reasonable distances and do not use the vehicles throughout the entire working day, there is a statistically demonstrable basic supply of electrical energy which is available for most of the time (working time). If that energy is regularly available those storage devices can also make a contribution to the regulating energy of wind power installations, which is being discussed at present and which is required in the network. That is particularly attractive if the vehicle storage devices are charged from regenerative sources. More specifically then those regenerative energy sources themselves generate and provide at least a part of the regulating energy required.

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